Mission Directorate:	Science
Theme:	Heliophysics

Theme Overview

Earth is immersed in a seemingly invisible yet exotic and inherently hostile environment. Above the protective cocoon of Earth's atmosphere is a plasma soup composed of electrified and magnetized matter entwined with penetrating radiation and energetic particles. The Sun's energy output, which varies on time scales from milliseconds to billions of years, forms an immense structure of complex magnetic fields. Inflated by the solar wind, this colossal bubble of magnetism, known as the heliosphere, stretches far beyond the orbit of Pluto. This extended atmosphere of the Sun drives some of the greatest changes in the local space environment, affecting the magnetosphere, ionosphere, atmosphere, and potentially, Earth's climate.

Heliophysics seeks understanding of the interaction of the large, complex, coupled system comprising the Sun, Earth, and Moon, other planetary systems, the vast space within the solar system, and the interface with interstellar space. Heliophysics flight missions form a fleet of solar, heliospheric, and geospace spacecraft that operate simultaneously to understand the coupled Sun-Earth system.

A robust heliophysics research program is critical to understanding how solar radiation drives the climate system and sustains the biosphere of Earth, and the environment faced by human and robotic explorers venturing into space. Solar particles and fields drive radiation belts, high-altitude winds, heat the ionosphere, and alter the ozone layer. The resulting space weather affects radio and radar transmissions, gas and oil pipelines, electrical power grids, and spacecraft electronics. As a result, scientific research in this area has the potential to return significant value to modern society. An effective research plan incorporates studying the Sun, heliosphere, and planetary environments as elements of a single interconnected system that contains dynamic space weather and evolves in response to solar, planetary, and interstellar conditions. NASA is working to advance this science that enables space weather prediction by answering fundamental questions about this system's behavior:

- What causes the Sun to vary?

- How do the Earth and the heliosphere respond?

- What are the impacts on human society?

Heliophysics strategic goals are achieved through four program lines: two strategic programs, one competed program, and a Research and Analysis program. Solar Terrestrial Probes, a strategic program, provides understanding of the fundamental processes inherent in astrophysical systems and their effects. Living With a Star, the other strategic program, emphasizes the science necessary to understand those aspects of the Sun and space environment that most directly affect life and society and that enable robotic and human exploration of the solar system. The Explorer Program consists of competitively selected small principal investigator-led missions that can be developed relatively quickly, providing frequent flight opportunities for world-class scientific investigations from space. The Heliophysics Research Program supports physics-based data analysis and modeling that has played an increasingly important role both in defining the missions and interpreting their observations.

Mission Directorate:	Science
Theme:	Heliophysics

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**608.0**	**-**	**577.9**	**591.0**	**612.4**	**627.2**	**628.6**
Heliophysics Research	171.8	-	144.5	147.5	149.3	149.5	150.8
Living with a Star	221.9	-	204.7	202.2	200.9	336.3	354.9
Solar Terrestrial Probes	148.0	-	163.5	170.4	171.9	50.2	38.0
Heliophysics Explorer Program	65.1	-	65.2	70.8	90.2	91.1	84.9
New Millennium	1.2	-	0.0	0.0	0.0	0.0	0.0

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Heliophysics Research

The research program will continue to operate 17 missions comprising 26 spacecraft through FY 2012. Heliophysics data centers will continue to archive and distribute collected science data.

Living with a Star

Radiation Belt Storm Probes (RBSP) has completed its System Integration Review and begun integration and test in preparation for launch, scheduled in May 2012. Solar Probe Plus will continue Phase B activities in FY 2012. The Solar Orbiter collaboration will transition into Phase B of formulation depending upon European Space Agency (ESA) Class M mission selections. The Solar Dynamics Observatory (SDO) will continue mission operations.

Solar Terrestrial Probes

The Magnetospheric Multiscale Mission (MMS) will continue in implementation. System Integration Review is planned for January 2012, and Key Decision Point (KDP) D review will be held in April 2012. STEREO and Hinode will continue extended mission operations.

Heliophysics Explorer Program

The Interface Region Imaging Spectrograph (IRIS), a Small Explorers mission, held a successful Critical Design Review in FY 2011 and is continuing implementation. IRIS System Integration Review is scheduled for December 2011, and KDP D to follow in January 2012. The IBEX, CINDI, TWINS, AIM, and THEMIS missions will continue extended mission operations. An Announcement of Opportunity for the next Explorer missions was released in FY 2011. Assuming no impact to Explorer Program budget, select missions will continue formulation in FY 2012.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Heliophysics Theme is guided by U.S. National Space Policy and follows NASA's tradition of establishing its priorities through consultation with world-class experts. Heliophysics relies on two advisory bodies for scientific assessments and decadal surveys: the National Academies' Space Studies Board and the NASA Advisory Council. Heliophysics missions, such as the Advanced Composition Explorer, provide critical data to the Department of Defense (DOD), the Federal Aviation Administration (FAA), and the National Oceanographic and Atmospheric Administration and help to guard the Nation against space weather impacts. The Living With a Star (LWS) Program targets research and technologies that are relevant to the operational needs of these agencies. The Nation's safety, security, and economy have become increasingly dependent on technologies that are susceptible to the extremes of space weather, i.e. severe disturbances of the upper atmosphere and of the near-Earth space environment that are driven by the magnetic activity of the Sun. Space weather events can damage satellites and power grids, and disrupt air traffic communications. Interagency activities are coordinated through the National Space Weather Program Council within the Office of the Federal Coordinator for Meteorology. Organizations around the world also access heliophysics data via the International Space Environment Service.

Through the Solar Terrestrial Probes Program, Heliophysics is also working to improve understanding of magnetic reconnection, a process that occurs throughout the universe when stressed magnetic field lines suddenly transition to a new shape. The understanding of magnetic reconnection as studied in space can play a critical role in the Department of Energy's efforts to develop fusion energy in a laboratory setting.

Relevance to the NASA Mission and Strategic Goals:

Heliophysics research supports NASA's Strategic Goal 2, to "Expand scientific understanding of the Earth and the universe in which we live."

Relevance to education and public benefits:

Society is increasingly dependent on modern technology, including power grids, global positioning systems, weather forecasting, and satellite communications. The valuable assets that support these technologies are vulnerable to solar activity and space weather events, so the need to predict solar events and mitigate their effect is critical to the public's safety, security, and the Nation's economy. A 2009 report by the National Academies titled "Severe Space Weather Events - Understanding Societal and Economic Impacts," for the first time attempted to quantify the effects of extreme space weather on the Nation. The report concludes that improving forecasting capabilities and raising public awareness are instrumental in mitigating severe consequences. The Heliophysics Program supports the rapid transition of research results, models, and data into operational products that benefit the public and other segments of the U.S. Government.

Heliophysics education programs include the award-winning "Family Science Night" that introduces local communities to a wide range of heliophysics-related topics. The program takes a multidisciplinary approach to educating and informing the public about such topics as light and spectrum, the seasons, and solar power. The IBEX mission has partnered with Adler Planetarium in Chicago to develop a planetarium show that communicates the scientific goals and results of the IBEX mission. The STEREO mission regularly provides selected images and movies to over 250 science centers through outreach programs and through the American Museum of National History in New York City. The Coordinated Modeling Center, a collaborative partnership with the National Science Foundation, National Oceanic and Atmospheric Administration, and the U.S. Air Force , provides the Nation with validation of innovative space weather numerical models. Output is used internationally by a wide variety of research and applications groups.

Mission Directorate:	Science
Theme:	Heliophysics

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**	
Outcome 2.2	**Understand the Sun and its interactions with Earth and the solar system.**	
Objective 2.2.1	**Improve understanding of the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.**	
Performance Goal 2.2.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.2.1.1: HE-12-1	Demonstrate planned progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.2.1.2	***By 2015, launch two missions in support of this outcome.***	
APG 2.2.1.2: HE-12-2	Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.	Solar Terrestrial Probes
APG 2.2.1.2: HE-12-3	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Living with a Star
Objective 2.2.2	**Improve understanding of how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres.**	
Performance Goal 2.2.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.2.2.1: HE-12-4	Demonstrate planned progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.2.2.2	***By 2015, launch two missions in support of this outcome.***	
APG 2.2.2.2: HE-12-2	Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.	Solar Terrestrial Probes
APG 2.2.2.2: HE-12-3	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Living with a Star

Mission Directorate:	Science
Theme:	Heliophysics

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Objective 2.2.3	**Maximize the safety and productivity of human and robotic explorers by developing the capability to predict extreme and dynamic conditions in space.**	
Performance Goal 2.2.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.2.3.1: HE-12-5	Demonstrate planned progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.2.3.2	***By 2017, launch at least two missions in support of this outcome.***	
APG 2.2.3.2: HE-12-3	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Living with a Star

Uniform and Efficiency Measures:

Measure #	Description
Heliophysics Theme	
APG EFF: HE-12-6	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: HE-12-7	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: HE-12-8	Peer-review and competitively award at least 90 percent, by budget, of research projects.
APG EFF: HE-12-9	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.

Mission Directorate:	Science
Theme:	Heliophysics

Performance Achievement Highlights:

Earth is affected by what happens on the Sun's surface even though Earth is 93 million miles away from the Sun. The Earth recently experienced an extended solar minimum and the Sun's magnetic activity is once again increasing. The Heliophysics fleet of 17 operating missions and the research and analysis (R&A) programs were coordinated to study this dynamic variation, enabling scientists around the world to investigate the behavior of the complex heliospheric system of systems. No 11-year solar cycle is exactly the same as another, and this research showed that sunspot activity during the 2007 - 2009 minimum was surprisingly low compared to cycles of the last century. The NASA observations were incorporated into state-of-the-art prediction models, and it is now believed that the solar cycle currently underway will be significantly different than previous cycles sampled since the start of the space age. This new understanding of the Sun's connection to Earth has provided essential information on space weather effects and will be used to improve the reliability of space weather warnings that affect technologies on Earth and the productivity and safety of explorers in space.

Observations during the recent unusually low solar minimum have resulted in many new discoveries about the underlying physics of the sunspot cycle. For example, NASA's measurements showed that solar wind pressure dropped 20 percent since the mid-1990s. Solar wind helps keep galactic cosmic rays out of the inner solar system: as the solar wind is flagging, more cosmic rays reach Earth and increase health hazards for astronauts. Weaker solar wind also means fewer geomagnetic storms and auroras, the northern and southern (polar) lights seen on Earth. Other NASA measurements showed that the Sun's brightness dimmed 0.02 percent at visible wavelengths and six percent at extreme ultraviolet wavelengths since the previous solar minimum. One effect of this change is that the upper atmosphere is less heated and not as "puffed up," which means that satellites in low Earth orbit experience less atmospheric drag, extending their operational lifetimes.

SDO was launched on February 11, 2010 and the observatory is returning images that demonstrate an unprecedented capability for scientists to understand the sun's dynamic processes. Using a combination of STEREO and the Japanese Hinode spacecraft, new solar atmospheric heating processes were visualized for the first time. The MMS mission completed its critical design review (CDR) and is finishing final design prior to the start of integration and testing. Instrument selections were completed for the Solar Probe Plus mission, which will fly into the Sun's atmosphere (or corona) for the first time. The RBSP completed the System Integration Review and started Phase D, integration and testing.

The IBEX mission, with its new technology, revealed new details of the interface between the solar system and the galaxy. IRIS CDR was held in December 2010 and the mission is continuing in Phase C. The Balloon Array for Radiation Belt Relativistic Electron Losses (BARREL) was confirmed in June 2010, and is now in the implementation phase having successfully completed a test campaign in Antarctica. The Sounding Rockets Program completed 13 suborbital launches. The Wallops Research Range provided telemetry and tracking services for four Shuttle missions, the 13 NASA suborbital launches, and the Ares 1-X test flight. The Range also upgraded several range instrumentation systems, e.g., video networks, range communications, and weather forecasting systems. Construction of the Wallops horizontal integration facility, which supports the Taurus-II missions, neared completion in 2010.

Mission Directorate:	Science
Theme:	Heliophysics

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	National Academies	12/2003	The Decadal Research Strategy assessed the current status and future directions of NASA's programs in solar and space physics research. The report identifies broad scientific challenges that define the focus and thrust of solar and space physics research for the decade 2003 through 2013. It presents a prioritized set of missions, facilities, and programs designed to address those challenges.	12/2013
Relevance	NAC/Helio-physics Subcommittee	09/2010	Release of the new Heliophysics Roadmap including science and program implementation strategies and relevance to the NASA strategies and goals. The roadmap lays out a new paradigm for mission planning and implementation that is expected to help control mission lifetime cost. The subcommittee stated that concerns remain with regard to R&A and Explorer Program level of funding.	10/2013
Performance	NAC/Helio-physics Subcommittee	07/2010	Reviews of selected annual performance goals as documented in Performance and Accountability Report (PAR). Review found that the Heliophysics Program has achieved its annual goals, and made significant progress toward understanding the local space environment and the fundamental science that is beginning to enable a reliable space weather predictive capability.	07/2011
Other	National Academies	03/2009	An ad hoc panel of the NRC conducted a mid-term performance assessment of the NASA Heliophysics Program. The report assessed NASA's progress against the 2003 decadal survey.	03/2013

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**171.8**	**-**	**144.5**	**147.5**	**149.3**	**149.5**	**150.8**
Heliophysics Research and Analysis	30.4	-	30.0	31.6	32.3	32.7	33.0
Sounding Rockets	48.7	-	45.5	46.5	47.3	47.8	48.2
Research Range	18.9	-	18.7	18.9	19.3	19.6	19.7
Other Missions and Data Analysis	73.8	-	50.4	50.4	50.3	49.5	49.8

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Program Overview

NASA's Heliophysics Research Program supports activities that address advancing understanding of the Sun and planetary space environments, including the origin, evolution, and interactions of space plasmas and electromagnetic fields throughout the heliosphere and in connection with the galaxy. Understanding the origin and nature of solar activity and its interaction with the space environment of the Earth is a particular focus. The program seeks to characterize these phenomena on a broad range of spatial and temporal scales, to understand the fundamental processes that drive them, to understand how these processes combine to create space weather events, and to enable a capability for predicting future space weather events.

The Heliophysics Research Program supports investigations of the Sun and planetary space environments from the 17 operating missions involving 26 spacecraft. This fleet of spacecraft is informally termed the "Heliophysics System Observatory," as the aggregation of data from all the spacecraft results in research synergies not possible with single observatories.

The Heliophysics Research and Analysis Program routinely solicits proposals in several broad areas in order to advance knowledge in support of NASA strategic goals. In addition, NASA occasionally offers special solicitations to take advantage of research opportunities that arise from the current solar environment. The research program also funds scientific investigations based on suborbital platforms, such as balloons or sounding rockets, and maintains some of the vital communications infrastructure at Wallops Flight Facility. The research and analysis and guest investigator projects fund more in-depth scientific investigations using all of this collected data via a competitive process that is held each year.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Plans For FY 2012

NASA's Heliophysics Research Program supports flight programs (sounding rockets, balloons, spacecraft) by formulating the theories of the phenomena to be studied; designing the experiments to test these theories; developing the instrument technology needed to execute the experiments; and incorporating results into computational models that can be used to more fully characterize the present state and future evolution of the heliophysics system.

The Supporting Research and Technology Program will hold its annual competition for new awards. Participation will be open to all categories of U.S. organizations, from educational institutions to other government agencies. The Geospace Science and Solar and Heliospheric Science sub-elements will hold annual competition for new awards. These sub-elements support detailed research tasks that employ a variety of research techniques, analysis, interpretation of space data, development of new instrument concepts, and laboratory measurements of relevant atomic and plasma parameters. The Theory Program supports large PI-proposed team efforts that require a critical mass of expertise to make significant progress in understanding complex physical processes with broad importance. The Low-Cost Access to Space (LCAS) sub-element supports scientific investigation and new instrument concepts to be flown on sounding rockets or balloons, as well as to prepare payloads for future sounding rockets and balloon launches.

Heliophysics data centers will be supported to continue the archival and distribution of collected science data. The Guest Investigator competition will support and extend the scientific impact of the currently operating missions. Science Data and Computing Technology will hold its annual competition for the Applied Information Systems Research Program. The Science Data and Computing Technology Program will continue to sustain the National Space Science Data Center.

The Research Range Program will provide launch instrumentation for NASA suborbital programs and projects.

Project Descriptions and Explanation of Changes

Heliophysics Research and Analysis

Supporting Research and Technology comprises an ever-evolving suite of individual PI-proposed investigations that cover the complete range of science disciplines and techniques essential to achieve the Heliophysics Theme objectives and to take full advantage of the scientific data collected by NASA missions. Supporting Research and Technology covers five sub-elements: Heliophysics Theory, Geospace Science, Solar and Heliospheric Science, Low-Cost Access to Space (LCAS), and Instrument Development.

The Heliophysics Theory sub-element is the intellectual compass of the Heliophysics Division. Teams work to consolidate the scientific understanding of previous missions and determine the scientific hypotheses to be tested by future strategic missions. This program supports large PI-proposed team efforts that require a critical mass of expertise to make significant progress in understanding complex physical processes with broad importance.

The Geospace Science sub-element supports studies of the physics of magnetospheres, including their formation and fundamental interactions with plasmas, fields, and particles. (Earth's magnetosphere is emphasized, but studies of the magnetospheres of planets, comets, and other primordial bodies are also supported). Geospace Science deals also with the physics of the mesosphere, thermosphere, ionosphere, and aurorae of Earth, including the coupling of these phenomena to the lower atmosphere and magnetosphere.

The Solar and Heliospheric Science sub-element supports studies that treat the Sun as a typical star, i.e., the dominant, time-varying source of energy, plasma, and energetic particles in the solar system (especially concerning its influence on Earth). This project investigates processes taking place throughout the solar interior and atmosphere: the evolution and cyclic activity of the Sun; the origin and propagation of the solar wind and magnetic field from the Sun to the heliopause (the boundary between the solar wind and the interstellar medium); the acceleration and transport of energetic particles in the heliosphere; and the interface of solar influence with the interstellar medium.

LCAS funds the science investigations that utilize suborbital sounding rockets, commercial reusable suborbital vehicles, or high altitude balloons, as well as proof-tests of new concepts in experimental techniques that may ultimately find application in free-flying heliophysics space missions. These investigations are developed and flown in a rapid turnaround environment. LCAS investigations address open science questions, but serve additional purposes not addressed in other flight programs, such as the training of experimental space physicists and engineers and the development and flight verification of new technology.

Instrument development investigations have as their objective the development of instrument technologies that show promise for use on future heliophysics science missions, including the development of prototypes. The goal is to define scientific instruments to the point where complete instruments may be proposed in response to future Announcements of Opportunity, without significant additional development.

Sounding Rockets

This project funds all suborbital mission activities (e.g., payload integration, launch, and mission operation) that support the science investigations funded in the Heliophysics Research and Analysis Program. Sounding Rockets present unique low-cost platforms that provide direct access to Earth's mesosphere (50-90 kilometers), lower thermosphere (90-120 kilometers), and Earth's magnetosphere (up to 1,500 kilometers). Because of their short duration and access to Earth's upper atmosphere and the space environment, sounding rocket suborbital missions also enable calibration under-flights of orbital missions, repeated proof-of-concept technology demonstration missions, and valuable end-to-end space mission experiences for scientists and engineers learning to develop and execute discovery-oriented orbital missions.

Research Range

The Research Range effort supports NASA's only test range, located at Wallops Flight Facility, for launch of suborbital and orbital vehicles, supporting launch operations, and tracking, telemetry and command (TT&C) capabilities. The Wallops Research Range also supports a mobile TT&C capability to support launches safely from a number of worldwide launch sites. The NASA Research Range is one of the few ranges in the Nation to offer a mobile capability. The range maintains it own airspace and supports a wide variety of small launch vehicles, suborbital missions, and airborne missions utilizing non-FAA-certified vehicles, such as unmanned aircraft systems.

Other Missions and Data Analysis

The research program is responsible for accumulating, archiving, and distributing the data collected by operating spacecraft. Current operating spacecraft include: Cluster II, ACE, Voyager, Wind, RHESSI, SOHO, and TIMED. It is this collective asset that enables the data, expertise, and research results that directly contribute to the national goal of real-time space weather prediction and to fundamental research on solar and space plasma physics. In April 2010, these missions underwent Senior Review. New budgets for FY 2011 and the outyears were determined, consistent with their evolving scientific goals.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Annual peer-reviewed research solicitation for grant opportunities	Research and Analysis	None

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Implementation Schedule

Project	Schedule by Fiscal Year																Phase Dates		
	Prior	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		Beg	End
Voyager																	Tech Form Dev Ops Res	Aug-77	Sep-14 Sep-15
Geotail																	Tech Form Dev Ops Res	Jul-92	Sep-14 Sep-15
Wind																	Tech Form Dev Ops Res	Nov-94	Sep-14 Sep-15
Solar and Heliospheric Observatory (SOHO)																	Tech Form Dev Ops Res	Dec-95	Sep-14 Sep-15
Advanced Composition Explorer (ACE)																	Tech Form Dev Ops Res	Aug-97	Sep-14 Sep-15
Cluster-II																	Tech Form Dev Ops Res	Jul-00	Sep-14 Sep-15
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED)																	Tech Form Dev Ops Res	Dec-01	Sep-14 Sep-15
RHESSI																	Tech Form Dev Ops Res	Feb-02	Sep-14 Sep-15

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

NASA Headquarters has program management responsibility for the Heliophysics Research Program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research and Analysis	SMD	All NASA Centers	None
Heliophysics Operating Missions	SMD	GSFC, JPL and MSFC	ESA and JAXA
Sounding Rockets and Research Range	SMD	GSFC	None
Science Data and Computing	SMD	GSFC and other NASA Centers	None

Acquisition Strategy

All acquisitions in the Heliophysics programs are based on full and open competition. Proposals are peer reviewed and selected based on NASA research announcements or Research Opportunities in Space and Earth Sciences (ROSES) opportunities. Universities, government research labs, and industry partners throughout the U.S. participate in R&A research projects. The Heliophysics operating missions and instrument teams were previously selected from NASA Announcements of Opportunity. NASA evaluates the allocation of funding among the operating missions bi-annually through the Heliophysics Senior Review. Universities, government research labs, and industry partners throughout the U.S. participate in science data and computing technology research projects.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	04/2010	Assess effectiveness of Heliophysics operational activities.	04/2013

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**221.9**	**-**	**204.7**	**202.2**	**200.9**	**336.3**	**354.9**
Radiation Belt Storm Probes (RBSP)	121.0	-	91.2	29.7	21.5	8.7	0.0
Solar Probe Plus	40.0	-	51.8	103.0	103.0	146.7	232.5
Other Missions and Data Analysis	60.9	-	61.6	69.5	76.5	181.0	122.4

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Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Program Overview

The Living with a Star (LWS) Program seeks to improve understanding of how and why the Sun varies, how the Earth and solar system respond, and most importantly, how this variability and response affect life on Earth. This improved understanding of solar variability (i.e., space weather) and its effects will lead to a reliable predictive capability for space weather. This capability is essential for successful future space exploration and increased use of complex technological systems to improve the safety and quality of life on Earth. LWS accomplishes its goals with a combination of new science missions and yearly science research grant opportunities.

SDO, the first mission of LWS launched in FY 2010, will complement and improve upon major capabilities of the Solar and Heliospheric Observatory (SOHO), launched in December 1995. SDO is designed to help scientists understand the Sun's influence on Earth and near-Earth space by studying the full-disc of the solar atmosphere on small scales of space and time and many wavelengths simultaneously.

The Sun's inconsistent activity produces variability in the Earth's radiation belts. The second LWS mission, the Radiation Belt Storm Probes (RBSP), will analyze these belts in unprecedented detail. Two identical spacecraft in elliptical orbits will make simultaneous measurements of processes that accelerate and transport radiation particles as they transit through Earth's radiation belts. RBSP results will enable the development of models for Earth's radiation belts and for other related but under-sampled planetary environments, such as Mars. Spacecraft and aeronautics engineers will apply the models to improve spacecraft design and to alert spacecraft and aircraft operators and pilots of predicted storms and ionizing radiation that could impact crew health or vehicle operations.

Two additional missions are currently developing mission concepts: SPP and the Solar Orbiter Collaboration (SOC). SPP will explore the Sun from very close range (inside 10 solar radii) to improve understanding of the generation and flow of the solar wind that links the Sun to the Earth and the solar system. SOC, led by ESA, will investigate the links between the solar surface, corona, and inner heliosphere from as close as 45 solar radii, and image the side of the Sun not visible from Earth. If SPP and SOC operations overlap, a unique opportunity will be realized for coordinated measurements in the inner heliosphere that will augment their combined science return.

For more information, please see http://lws.gsfc.nasa.gov/.

Plans For FY 2012

The SDO mission will continue prime operations. RBSP has completed its System Integration Review and started integration and testing (I&T) in preparation for its launch, scheduled for May 2012.

The SOC and SPP missions will develop detailed requirements and further define their mission concepts during formulation. SPP will also continue to retire technology risks and develop instrument and spacecraft systems. The Space Environment Testbed awaits its upcoming launch in FY 2013. The Balloon Array for Radiation-belt Relativistic Electron Losses project will conduct its mission readiness review for its first science campaign in August 2012.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Project Descriptions and Explanation of Changes

Radiation Belt Storm Probes (RBSP)

The RBSP mission will improve the understanding of how solar storms interact with and change particles, fields, and radiation in Earth's Van Allen radiation belts and atmosphere. This knowledge could be applied to planets and moons in the solar system that have a magnetic core. This mission was recently approved to begin Phase D, hardware I&T, and is scheduled to launch in May 2012. Additional detail can be found in the RBSP development section of the NASA budget.

Solar Probe Plus

The SPP mission is currently in formulation. It will perform the first in-situ measurements very close to the Sun (as close as 9.5 solar radii) to improve understanding of the generation and flow of the solar wind that links the Sun to Earth and the solar system. The science instruments were selected in FY 2010 in support of a FY 2018 launch, the earliest possible launch date within funding guidelines and technology capability. Additional detail can be found in the SPP formulation section of the NASA budget.

Other Missions and Data Analysis

SDO: The SDO mission was launched in February 2010 on the Atlas V vehicle. SDO investigates how the Sun's magnetic field is structured, as well as how its energy is converted and released into the heliosphere in the forms of solar wind, energetic particles, and variations in solar irradiance.

Space Environment Testbeds (SET): SET will improve the engineering approach to accommodate and/or mitigate the effects of solar variability on spacecraft design and operations. It has two components: a data mining element that has been completed, and a space flight mission. SET is scheduled to fly on the Air Force Research Lab's Demonstration and Science Experiment mission scheduled for launch in FY 2013.

BARREL: BARREL is a balloon-based mission that will launch a series of science instruments to complement the measurements made on the RBSP mission. BARREL will measure the precipitation of relativistic electrons from the radiation belts. Implementation responsibility has been assigned to the Wallops Balloon Program Office.

SOC: SOC is a joint mission with ESA, wherein ESA provides the spacecraft operations and the majority of the instruments, pending final mission selections no earlier than September 2011. The LWS Program will provide the launch vehicle and up to four science investigations/instruments. These instruments were selected in FY 2009 and will complete formulation work in FY 2011. SOC will provide close-up views of the Sun's polar regions and its far side, and tune its orbit to match the Sun's rotation. This will permit the spacecraft's instruments to observe emissions and solar wind from one specific area for much longer than is currently possible and will provide more insight into the evolution of sunspots, active regions, coronal holes, and other solar features and phenomena than past missions.

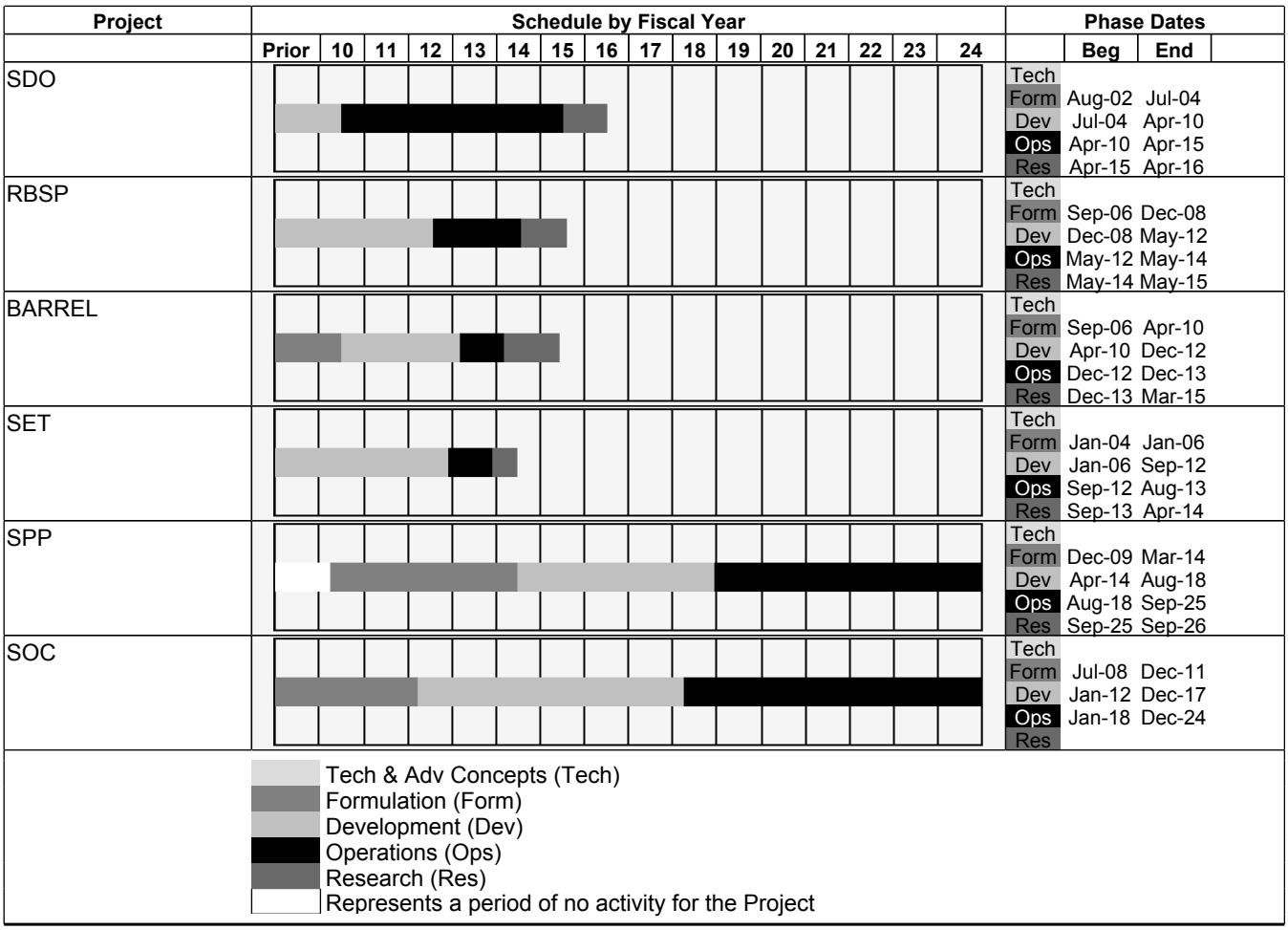
Living with a Star Science: LWS science funds competitively selected proposals that improve the understanding of the physics of the integrated system that links the Sun to the heliosphere and planetary atmospheres. This improved understanding will be achieved through data analysis supporting the development of new or revised theories and numerical models. This step is necessary for development of a predictive capability for space weather.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	RBSP	
Complete the Solar Orbiter Collaboration Confirmation Review.	Living with a Star	

Implementation Schedule



Program Management

Program management responsibility for the LWS Program is assigned to the LWS Program Office located at the Goddard Space Flight Center (GSFC).

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
SDO	GSFC	GSFC	None
RBSP	JHU-APL	None	National Reconnaissance Office (NRO)
BARREL	GSFC	GSFC	None
Solar Probe Plus	JHU-APL	None	None
SOC	GSFC	GSFC	European Space Agency, ESA member states
SET	GSFC	GSFC	CNES (French Space Agency), DLR (German Space Agency), UKSA (United Kingdom Space Agency), BIRA (Belgian Space Agency), INAF (Italian National Institute for Astrophysics), MICINN (Spanish Ministry of Science and Innovation), SSO (Swiss Space Office)

Acquisition Strategy

Four instrument suites for RBSP were selected through full and open competition, and one instrument is being provided by the National Reconnaissance Office. The launch vehicle was selected through full and open competition, and the spacecraft are being built in-house at Johns Hopkins University-Applied Physics Laboratory (JHU-APL).

BARREL was selected through full and open competition through the same solicitation as the RBSP instruments. Two SET experiments were selected through full and open competition, and two were contributed by Centre National d'Etudes Spatiales (CNES) and Defense Evaluation and Research Agency.

NASA-led SOC and SPP instruments were selected using full and open competition as were the SPP and SOC launch vehicles. The SPP spacecraft will be built in-house at JHU-APL.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	02/2009	Overall assessment of the life cycle cost, schedule and deliverables of the LWS Program. Review board concluded that these programs have met their success criteria and should continue in accordance with their existing plans.	02/2013

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**271.3**	**121.0**	**-**	**91.2**	**29.7**	**21.5**	**8.7**	**0.0**

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

RBSP was confirmed in FY 2009 to proceed into the development phase, and will launch in May 2012. The total funding for RBSP has not changed.

Project Purpose

The RBSP mission will observe the fundamental processes that energize and transport radiation particles in Earth's inner magnetosphere (the area in and around Earth's radiation belts). These dynamic processes operate throughout the universe at other planets and stars, and they continuously operate within Earth's immediate space environment.

The primary science objective of the RBSP mission is to provide understanding, ideally to the point of predictability, of how populations of relativistic electrons and penetrating ions in space form or change in response to variable inputs of energy from the Sun. The RBSP mission lifetime will provide sufficient local time, altitude, and event coverage to improve understanding, and determine the relative significance of the various mechanisms that operate within the radiation belts.

RBSP observations will provide new knowledge on the dynamics and extremes of the radiation belts that are important to all technological systems that fly in and through geospace.

Project Parameters

The RBSP mission is comprised of two identical spacecraft in elliptical, low-inclination orbits that travel independently through Earth's radiation belts to distinguish time and space variations in the measured ions, electrons, and fields.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Commitments

The RBSP project will launch two identical spacecraft in FY 2012 to begin a two-year prime mission.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
EELV	KSC	Deliver a spacecraft to operational orbit	Same	Same
Energetic Particle, Composition and Thermal Plasma Suite (ECT)	University of New Hampshire	Measure the electron and ion spectra, and composition to understand the electron and ion changes	Same	Same
Radiation Belt Storm Probes Ion Composition Experiment (RBSPICE)	New Jersey Institute of Technology	Measure the ring current in the magnetosphere during geomagnetic storms	Same	Same
Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS)	University of Iowa	Measure the magnetic fields and plasma waves	Same	Same
Electric Field and Waves Instrument for the NASA RBSP Mission (EFW)	University of Minnesota	Measure the electric fields in the radiation belts	Same	Same
Proton Spectrometer Belt Research (PSBR)	National Reconnaissance Office	Measure the inner Van Allen belt protons	Same	Same
Spacecraft	JHU-APL	Operate science instruments in high radiation; transmit science data to ground	Same	Same
Ground System	Primary ground station at JHU-APL; instrument operation is distributed among investigators	Receive science data from two spacecraft; distribute to archive	Same	Same

Schedule Commitments

The RBSP project was authorized to begin formulation in September 2006 when the selections for science investigations were announced. It was confirmed to proceed into development on December 19, 2009.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Begin Implementation	January 2009	January 2009	January 2009
Critical Design Review	December 2009	December 2009	December 2009
System Integration Review	November 2010	November 2010	October 2010
Launch Readiness Review	May 2012	May 2012	May 2012

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Management

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Ground Systems	JHU-APL	None	None
Data Analysis	JHU-APL	None	National Reconnaissance Office
Instrument Development	JHU-APL	None	National Reconnaissance Office
Spacecraft design, integration with instrument, and test	JHU-APL	None	None
Mission Operations	JHU-APL	None	None
Expendable Launch Vehicle	KSC	None	None

Acquisition Strategy

The RBSP spacecraft and ground system are being designed, developed, and tested at the JHU-APL. The acquisition of sub-contracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the JHU-APL Procurement Office. Instrument development participants include the University of Iowa, University of Minnesota, New Jersey Institute of Technology, and the University of New Hampshire, as well as contributions from the National Reconnaissance Office and the Czech Republic.

The ground system components were defined during the formulation phases (Phases A and B) and include a mission operations center at the JHU-APL.

The Energetic Particle, Composition and Thermal Plasma Suite (ECT), Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS), Electric Field and Waves Instrument for the NASA RBSP mission (EFW), and Radiation Belt Storm Probes Ions Composition Experiment (RBSPICE) science investigations were procured through announcements of opportunity. The Proton Spectrometer Belt Research (PSBR) instrument is being contributed through an agreement with the National Reconnaissance Office.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Senior Review Board	10/2008	Preliminary Design Review. The review concluded that the RBSP design was sufficiently mature to proceed to KDP-C.	N/A
Performance	SRB	12/2009	Critical Design Review: The review concluded that there were no significant issues and the project should continue as planned.	N/A
Performance	SRB	10/2010	System Integration Review: The review concluded that the project was ready to proceed with I&T.	N/A

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Complete Electric and Magnetic Field Instrument Suite and Integrated Science End-to-End testing	If the Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) main Electronics Box Engineering Model 2 (EM2) is not successfully integrated and tested per the EM2 test plan and schedule, then the flight build and delivery will be delayed.	Hold Flight Manufacturing Readiness Reviews. Complete EM 2 environmental testing and characterization. Complete EM2 I&T peer review.
XCVR Qualification program	If the transceiver qualification program does not perform to their re-planned schedule, then the project's I&T schedule will be delayed.	Provide bi-weekly schedule updates to the integrated master schedule. Burn Qualification model on the RTAX, the field programmable gate array. Conduct Engineering Design Review of Qualification model.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	40.0	-	51.8	103.0	103.0	146.7	232.5

Note:

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In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Project Purpose

Solar Probe Plus (SPP) will be an extraordinary and historic mission, exploring the Sun's outer atmosphere, or corona, as it extends out into space. Approaching as close as 9.5 solar radii, SPP will repeatedly sample the near-Sun environment, revolutionizing knowledge and understanding of coronal heating and of the origin and evolution of the solar wind, answering critical questions in heliophysics that have been ranked as top priorities for decades. Moreover, by making direct, in-situ measurements of the region where some of the most hazardous solar energetic particles are energized, SPP will make a fundamental contribution to the ability to characterize and forecast the radiation environment in which future space explorers will work and live.

For more information about SSP, please see http://nasascience.nasa.gov/missions/solar_probe.

Project Preliminary Parameters

SPP's first near-Sun pass occurs three months after launch, at a heliocentric distance of 35 solar radii. Over the next several years, successive Venus gravity assist maneuvers will gradually lower the spacecraft's near-Sun pass to approximately 9.5 solar radii, by far the closest any spacecraft has ever come to the Sun. An August 2018 launch is the earliest possible launch date within funding guidelines and technology capability. SPP will spend, during its seven year mission, a total of 30 hours inside 10 solar radii, 961 hours inside 20 solar radii, and 2149 hours inside 30 solar radii, sampling the solar wind as it evolves with rising solar activity toward an increasingly complex structure.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

Estimated Project Deliverables

SPP will launch from KSC on an EELV in FY 2018 with an expected mission duration of seven years.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
EELV	KSC	Deliver the spacecraft to operational orbit	Same	Same
Ground Systems	JHU-APL	Receive science data and telemetry from spacecraft, command spacecraft, distribute science data to investigator teams	Same	Same
Spacecraft	JHU-APL	Transport instruments to science destination, operate instruments, modify orbit including several Venus gravity assists	Same	Same
Instruments	NASA-funded investigators	Perform in situ measurements and remote observations of the Sun	Same	Same

Estimated Project Schedule

SPP received approval to proceed to Phase A in November 2009 and to solicit science investigations in December 2009. NASA announced these selections in September 2010. Phase B will begin in the fall of 2011 following a successful Mission Definition Review/Preliminary Non-Advocate Review (PNAR).

Milestone Name	Formulation Agreement Estimate	FY 2011 PB Request	FY 2012 PB Request
Formulation			
Mission Definition Review /PNAR	01/2012	04/2012	10/2011
Preliminary Design Review/NAR	01/2014	N/A	01/2014
Critical Design Review	01/2016	N/A	11/2015
Launch	08/2018	08/2018	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

Project Management

JHU-APL will manage the project. GSFC is responsible for program management and science management

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Instruments	JHU-APL	None	None
EELV	JHU-APL	KSC	None
Spacecraft	JHU-APL	None	None
Mission Operations	JHU-APL	None	None

Acquisition Strategy

The science instruments will be built by PIs selected through the Announcement of Opportunity. The spacecraft will be built by JHU-APL with the spacecraft subassemblies, components, and parts competitively procured by JHU-APL. The ground system components will be defined during formulation and will be determined by the implementing organization for the project. The Phase E contracts will be managed by GSFC.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Senior Review Board	09/2009	SRB approved the project to proceed into Phase A.	10/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
1. Thermal protection system (TPS) thermal performance	If TPS thermal conductivity is greater than required and/or the coating performance is less than required, then the cooling system and spacecraft radiators may not be able to remove sufficient heat, leading to elevated solar array and spacecraft temperature.	- Coating development work. - Early materials characterization. - Early manufacture and test of prototype articles. - Increased TPS thickness.
2. Solar cell and array performance	If solar cell and array performance in the near-Sun environment is less than expected, then the power system performance may not meet requirement and/or cooling system requirements may increase.	- Cell technology development work. - Extensive power system and solar cell modeling and test. - Parallel approaches to development and design. - Margins in power and cooling system design. - Prototype development.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**148.0**	**-**	**163.5**	**170.4**	**171.9**	**50.2**	**38.0**
Magnetospheric Multiscale (MMS)	130.1	-	146.2	153.0	153.0	30.5	18.6
Other Missions and Data Analysis	17.9	-	17.3	17.4	18.9	19.7	19.4

Note:

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In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

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Program Overview

Solar Terrestrial Probes (STP) provide understanding of the fundamental plasma processes inherent in all astrophysical systems. To accomplish this goal, STP investigations focus on specific scientific areas that will help us understand how plasma behaves in the space between the Sun and Earth. STP missions address processes such as the variability of the Sun, the responses of the planets to these variations, and the interaction of the Sun and solar system. STP missions are strategically defined and investigations are competitively selected. Strategic mission lines afford the space physics community the opportunity to plan specific missions to address important research focus areas and thus make significant progress in elucidating the fundamental processes of heliophysics.

For more information please see the STP program at http://stp.gsfc.nasa.gov/.

Plans For FY 2012

The Magnetospheric Multiscale Mission (MMS) will continue the implementation phase . System integration review is planned for January 2012, and KDP D will be held in April 2012. STEREO and Hinode will continue extended mission operations.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

Project Descriptions and Explanation of Changes

Magnetospheric Multiscale (MMS)

MMS is a four-spacecraft mission planned for launch in March 2015 with a two-year mission life. MMS is designed to study magnetic reconnection in key boundary regions of Earth's magnetosphere. Reconnection is a fundamental process that occurs throughout the universe, by which magnetic energy is converted into heat, radiation, and particle acceleration. The best laboratory for understanding this process is Earth's magnetosphere, where reconnection between Earth's and the Sun's magnetic fields power magnetic storms, and substorms on Earth. The spacecraft will probe the regions of geospace most critical to measuring reconnection. Additional detail can be found in the MMS development section of this document.

Other Missions and Data Analysis

Solar TErrestrial RElations Observatory (STEREO): Launched on October 25, 2006, STEREO is now an operating mission employing two nearly identical observatories to provide three-dimensional measurements of the Sun to study the nature of coronal mass ejections. These powerful eruptions are a major source of the magnetic disruptions on Earth and a key component of space weather, which can greatly affect satellite operations, communications, power systems, the lives of humans in space, and global climate.

Solar B (Hinode): Hinode launched on September 22, 2006, from Japan's Uchinoura Space Center. Its mission is to explore the magnetic fields of the Sun. NASA developed three science instrument components: the Focal Plane Package (FPP), the X-Ray Telescope (XRT), and the Extreme Ultraviolet Imaging Spectrometer (EIS) and provides operations support for science planning and instrument command generation activities. A follow-on to the highly successful Japan/US/UK Yohkoh (Solar-A) satellite that operated between 1991 and 2001, Hinode consists of a coordinated set of optical, Extreme-Ultraviolet (EUV), and X-ray instruments that will investigate the interaction between the Sun's magnetic field and its corona.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.	MMS	

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

Implementation Schedule

Project	Schedule by Fiscal Year																Phase Dates		
	Prior	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		Beg	End
Magnetospheric Multiscale (MMS)																	Tech		
																	Form	May-02	Jun-09
																	Dev	Jun-09	Mar-15
																	Ops	Mar-15	Jul-17
																	Res	Jul-17	Jul-18
STEREO																	Tech		
																	Form	May-01	Mar-02
																	Dev	Mar-02	Jan-07
																	Ops	Jan-07	Sep-14
																	Res	Oct-14	Sep-16
Solar-B (Hinode)																	Tech		
																	Form	Dec-98	Nov-00
																	Dev	Nov-00	Nov-06
																	Ops	Nov-06	Sep-14
																	Res	Oct-14	Sep-16

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

Program management responsibility for the STP program is assigned to the STP Program Office at GSFC.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
MMS	GSFC	GSFC	Austria, France, Japan, Sweden (SNSB)
STEREO	GSFC	None	United Kingdom

Acquisition Strategy

STP missions are strategically defined and investigations are competitively selected. For the acquisition of scientific instruments, spacecraft, and science investigations, including research and analysis, STP uses full and open competitions to the greatest extent possible.

The MMS spacecraft will be built in-house at GSFC. GSFC will also provide the mission operations center. The Southwest Research Institute (SwRI) is the single MMS instrument suite contractor, selected through a full and open competition. All instruments are developed by SwRI, their subcontractors, their international partners, and GSFC.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	08/2010	Overall assessment of life cycle cost, schedule, and deliverables of the STP Program. The review board concluded that this program has met the success criteria and should continue in accordance with their existing plans.	N/A

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Development:	Magnetospheric Multiscale (MMS)

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**226.0**	**130.1**	**-**	**146.2**	**153.0**	**153.0**	**30.5**	**18.6**

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

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Explanation of Project Changes

MMS has no change in life cycle cost. Sweden is not able to deliver the deployment mechanism of their electric field instrument contribution as planned. This mechanism will now be built by NASA through an existing partner institution, the University of New Hampshire.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Development:	Magnetospheric Multiscale (MMS)

Project Purpose

MMS will use four identically instrumented spacecraft to perform the first definitive study of magnetic reconnection in space. Reconnection occurs in all astrophysical plasma systems but can be studied efficiently only in Earth's magnetosphere. Magnetic reconnection is thought to be of great importance for energy transfer throughout the universe and is an efficient and fast acceleration mechanism. Reconnection is the primary process by which energy is transferred from the solar wind to Earth's magnetosphere and is the critical physical process determining the size of a space weather geomagnetic storm. MMS will determine why magnetic reconnection occurs, where it occurs, how it varies, how magnetic energy is coupled into heat and particle kinetic energy, and how this energy is coupled into the surrounding plasma.

For more information about MMS, please see http://stp.gsfc.nasa.gov/missions/mms/mms.htm.

Project Parameters

The MMS instrument payload will measure electric and magnetic fields and plasmas within the small-scale diffusion regions where magnetic reconnection occurs. High temporal and spatial resolution measurements will permit direct observation of these physical processes. The four spacecraft and instrument suites have identical design requirements. A two-phase, low-inclination orbit will probe both the dayside magnetopause and the nightside magnetotail neutral sheet where reconnection is known to frequently occur. The primary target of Phase 1 is the dayside magnetopause reconnection region. Phase 2 will focus on the near-Earth neutral line in the nightside magnetotail. The four spacecraft will fly in a tetrahedron formation and the separation between the observatories will be adjustable over a range of 10 to 400 kilometers during science operations in the area of interest. The mission design life is two years.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Development:	Magnetospheric Multiscale (MMS)

Project Commitments

NASA plans to launch four identically-instrumented spacecraft on an Evolved Expendable Launch Vehicle (EELV) into a highly elliptical Earth orbit in March 2015 and begin two years of scientific measurements that will enable an understanding of fundamental plasma physics processes associated with magnetic reconnection.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Launch Vehicle	KSC	Deliver ~4,000 kg payload consisting of four observatories to a highly elliptical Earth orbit.	Same	Same
Ground Systems	GSFC	Provide during operations minimum science data payback of ~4 Gbits of data per observatory each day.	Same	Same
Spacecraft	GSFC	Deliver high-rate data from instruments to ground station with a high accuracy for two years.	Same	Same
Electric Field Instruments	UNH	Provide measurements of electric fields (time resolution 1 ms) and magnetic fields (time resolution 10 ms)	Same	Same
Fast Plasma Investigation	GSFC	Provide plasma wave measurements (electric vector to 100 KHz).	Same	Same
Energetic Particle Detectors	JHU-APL	Provide high-resolution measurement of energetic particles.	Same	Same
Hot Plasma Composition Analyzers	Southwest Research Institute	Three-dimensional measurements of hot plasma composition (time resolution 10s).	Same	Same
Science Operations Center	University of Colorado/ Laboratory for Atmospheric and Space Physics	Provide science data to the community and archive.	Same	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Development:	Magnetospheric Multiscale (MMS)

Schedule Commitments

MMS began formulation in FY 2002. The project's confirmation review was held in June 2009 and the project was approved to enter implementation. As a result of the confirmation review, the launch date was moved to March 2015. The Mission Critical Design Review was successfully completed in August 2010.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Mission Definition Review	September 2007	September 2007	September 2007
Initial Confirmation Review	November 2007	November 2007	November 2007
Confirmation Review	June 2009	June 2009	June 2009
Critical Design Review	August 2010	August 2010	August 2010
System Integration review	January 2012	January 2012	January 2012
Launch	March 2015	March 2015	March 2015

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Development:	Magnetospheric Multiscale (MMS)

Project Management

The STP Program has program management responsibility for the MMS project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Four Instrument Suites	GSFC, Southwest Research Institute	GSFC	Austrian Space Agency, France (CNES), and Japan (JAXA), Sweden (SNSB)
Launch Vehicle	KSC	KSC	None
Four Spacecraft	GSFC	GSFC	None
Mission Operations	GSFC	GSFC	None
Science Operations	GSFC, LASP	None	None

Acquisition Strategy

The MMS spacecraft is being designed, developed, and tested in-house at GSFC using a combination of GSFC civil servants and local support service contractors. The acquisition of subcontracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the MMS procurement office. Instrument development activities are under contract with SwRI. Instrument development subcontracts include Lockheed Martin, JAXA/MEISEI, University of New Hampshire, JHU-APL, Aerospace Corporation, and a team at GSFC. The Mission Operations Center and the Flight Dynamics Operations Area will be developed and operated at GSFC using a combination of GSFC civil servants and local support service contractors. The Science Operations Center for the instruments will be developed and operated at the Laboratory for Atmospheric and Space Physics at the University of Colorado and is under contract to SwRI.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	SRB	08/2010	The Critical Design Review (CDR), an NPR 7120.5D review to assess the technical, cost, and schedule status of MMS. MMS was approved to proceed to manufacturing.	01/2012
All	SRB	N/A	System Integration Review - Evaluate the readiness of the project to start flight system assembly, test, and launch operations.	03/2014
All	SRB	N/A	Flight Readiness Review - Evaluate system assembly, integration, and test, preparing for the flight.	TBD

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**65.1**	**-**	**65.2**	**70.8**	**90.2**	**91.1**	**84.9**
IRIS	41.1	-	37.5	11.2	6.8	1.1	0.0
Other Missions and Data Analysis	24.0	-	27.7	59.7	83.4	90.1	84.9

Note: The above budget submit reflects split of the Explorer Future budget for the Heliophysics Theme only.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Program Overview

The Explorer Program provides frequent flight opportunities for world-class astrophysics and space physics investigations using innovative and streamlined management approaches for spacecraft development and operations. Explorer missions are highly responsive to new knowledge, new technology, and updated scientific priorities by launching smaller missions that can be conceived and executed in a relatively short development cycle. Priorities are based on an open competition of concepts solicited from the scientific community.

The program also enables participation in missions of opportunity provided by other U.S. or international agencies. The program emphasizes missions that can be accomplished under the control of the scientific research community within constrained mission life-cycle costs. The program also seeks to enhance public awareness of space science by incorporating educational and public outreach activities into each mission. All investigations are competitively selected. Full missions can either be medium-class explorers (MIDEX) or small explorers (SMEX). Missions of opportunity space science investigations are typically instruments flown as part of a non-NASA space mission. Missions of opportunity are conducted on a no-exchange-of-funds basis with the organization sponsoring the mission.

Following the commissioning and checkout phase of the spacecraft, NASA Headquarters management responsibility for the operational phase transitions to the Heliophysics Research Program. While the research program assumes management responsibilities, funds for operating missions are provided by the Explorer Program.

The Explorer Program made two full mission selections from its SMEX competition during FY 2009. IRIS is a heliophysics small explorer mission, currently in the development phase, and scheduled for launch in CY 2012. The Gravity and Extreme Magnetism SMEX (GEMS) is an astrophysics small explorer mission selected for launch in FY 2014.

The Interstellar Boundary Explorer (IBEX), launched in October 2008, finished its prime operational phase in October 2010, and is currently in extended Phase E pending the results of the End of Prime Mission review. The Coupled Ion Neutral Dynamics Investigation (CINDI), and Two Wide-angle Imaging Neutral-atom Spectrometers B (TWINS) were also launched in FY 2008. Both CINDI and TWINS missions have gone under successful End of Prime Mission Reviews and the missions are being extended to September 2014.

The Explorer Program also has three Explorer missions currently in the Astrophysics Division. Details and the associated budget can be found in the Astrophysics Division section of the NASA budget.

For more information on any of the Explorer mission and new science discoveries, please see http://explorers.gsfc.nasa.gov/missions.html.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Plans For FY 2012

Explorer missions were conceived in response to the temporary unavailability of mid-range expendable launch vehicles. Explorer missions will accomplish world-class science via spacecraft whose capabilities are expected to fall between the SMEX and MIDEX classes. Access to space will utilize one of the several, lower-cost expendable launch vehicles currently available.

The currently approved Explorer Program planning budget is sufficient to select and execute at least one full Explorer mission to proceed into Phase B and subsequent mission phases. In FY 2011, SMD released an Announcement of Opportunity for new Explorer missions. Proposals are due no later than February 16, 2011. NASA intends to select and execute a second full Explorer mission or one or more mission(s) of opportunity. The decision between these selection options will be based upon the proposals received in response to this Announcement of Opportunity.

In FY 2012, funding for future Explorer missions (previously funded solely under the Heliophysics Explorer Program) is being shared by Heliophysics and Astrophysics. This will have no effect on the current Explorer Announcement of Opportunity for either Astrophysics or Heliophysics proposals, or the management of the program. In addition, this will balance the funding for Explorer missions between Astrophysics and Heliophysics in the future.

The newly selected IRIS mission will continue to progress in the development phase. The IBEX mission will continue its extended science mission of mapping the heliosphere and uncovering the global interaction between the solar wind and the interstellar medium, subject to the outcome of the review. TWINS and CINDI will both enter their fourth year on orbit. THEMIS and AIM will continue their extended Phase E operations.

Project Descriptions and Explanation of Changes

IRIS

IRIS is a SMEX mission selected in June 2009 and expected to launch June 2013. IRIS is currently in the development phase. This mission opens a window of discovery by tracing the flow of energy and plasma through the Sun's chromosphere and transition region into the corona. IRIS will revolutionize understanding of energy transport into the corona and solar wind and provide an archetype for all stellar atmospheres. The unique instrument capabilities, coupled with state of the art 3-dimensional modeling, will fill a large gap in the knowledge of this dynamic region of the solar atmosphere. The mission will greatly extend the scientific output of existing heliophysics spacecraft that follow the effects of energy release processes from the Sun to Earth.

Other Missions and Data Analysis

The primary objective of the Aeronomy of Ice in Mesophere (AIM) mission is to understand why polar mesospheric clouds form and why they vary. AIM will also determine the causes of Earth's highest-altitude clouds, which form in the coldest part of the atmosphere about 50 miles above the polar regions every summer. AIM launched on April 25, 2007, on board a Pegasus XL from Vandenberg Air Force Base. It completed its prime mission in FY 2009 and is currently in extended phase until September 2014. This mission supplies not previously available data, which has led to new science discoveries.

CINDI is a NASA-sponsored mission of opportunity managed by the University of Texas at Dallas (UTD). CINDI will discover the role of ion-neutral interactions in the generation of small- and large-scale electric fields in Earth's upper atmosphere. In addition, the CINDI instruments will provide measurements of the three-dimensional neutral winds and ion drifts. This mission launched April 16, 2008, aboard the Air Force Research Laboratory's Communication/Navigation Outage Forecast System (C/NOFS) spacecraft. Currently CINDI is in extended phase until September 2014.

IBEX allows the first glimpse into the edge of the solar system, where the solar wind interacts with winds from other stars. This region is a breeding ground for anomalous cosmic rays that form a component of energetic particles from beyond the solar system that may pose health and safety hazards for humans exploring beyond Earth's orbit. IBEX will make observations from an elliptical Earth orbit that takes it beyond the interference of Earth's magnetosphere. IBEX launched on October 5, 2008, on a Pegasus XL from Kwajalein Atoll in the Republic of the Marshall Islands. The IBEX spacecraft has made it possible for scientists to construct the first comprehensive sky map of the solar system and its location in the Milky Way galaxy. The new view will change the way researchers view and study the interaction between the galaxy and the Sun. This mission is currently in extended Phase E pending the results of the End of Prime Mission review.

Time History of Events and Macroscale Interactions during Substorms (THEMIS) has provided breakthroughs in understanding of the onset and evolution of magnetospheric substorms. NASA's THEMIS mission uses five identical micro-spacecraft (probes) to answer the fundamental questions regarding magnetospheric substorm instability, a dominant mechanism of transport and explosive release of solar wind energy within geospace. In addition to addressing its primary objective, THEMIS answers critical questions in radiation belt physics and solar wind-magnetosphere energy coupling. THEMIS is a MIDEX mission that launched on February 17, 2007, and is currently operating in extended phase until September 2014.

TWINS-B will provide the second half of the stereo imaging capability of Earth's magnetosphere in conjunction with the TWINS-A mission. The region surrounding the planet is controlled by its magnetic field and contains the Van Allen radiation belts and other energetic charged particles. TWINS-B will enable three-dimensional global visualization of this region, which will lead to a greatly enhanced understanding of the connections between different regions of the magnetosphere and their relation to the solar wind. TWINS-B was launched as a NASA-sponsored Mission of Opportunity in February 2008 and is currently operating in Extended Phase until September 2014.

The Explorer Future Missions funds future Heliophysics Explorer mission selections for the MIDEX, SMEX, Missions of Opportunity (MO), and Explorer (EX).

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Selection completed for announcement of opportunity; Start Development Phase on Explorer 1	Explorer Future mission	New

Implementation Schedule

Project	Schedule by Fiscal Year															Phase Dates		
	Prior	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		Beg	End
AIM																	Tech		
																	Form	Jul-02	Apr-04
																	Dev	Apr-04	May-07
																	Ops	May-07	May-13
																	Res	May-13	Sep-14
IBEX																	Tech		
																	Form	Jan-05	Mar-06
																	Dev	Mar-06	Oct-08
																	Ops	Oct-08	Sep-13
																	Res	Sep-13	Sep-14
THEMIS																	Tech		
																	Form	Oct-02	Apr-04
																	Dev	Apr-04	Aug-07
																	Ops	Aug-07	Aug-13
																	Res	Aug-13	Sep-14
CINDI																	Tech		
																	Form	Sep-00	Nov-01
																	Dev	Nov-01	Apr-08
																	Ops	Apr-08	Sep-12
																	Res	Sep-12	Sep-14
TWINS-B																	Tech		
																	Form		
																	Dev	Apr-99	Feb-08
																	Ops	Feb-08	Sep-12
																	Res	Sep-12	Sep-14
IRIS																	Tech		
																	Form	Jun-09	Jun-10
																	Dev	Jun-10	Dec-12
																	Ops	Dec-12	Jan-15
																	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

GSFC has program management responsibility for all Heliophysics Explorer programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
AIM	GSFC	None	N/A
IBEX	GSFC	GSFC	N/A
THEMIS	GSFC	None	N/A
CINDI	GSFC	None	DOD
TWINS-B	GSFC	None	DOD
IRIS	GSFC	ARC	N/A

Acquisition Strategy

The Heliophysics Explorer Program has established an acquisition strategy that contracts for the whole mission (concept through delivery of science data and analysis), with emphasis on performance incentives and a cost cap for each mission.

Investigations are selected through Announcements of Opportunity, in which multiple investigations are selected competitively for initial concept studies with a competitive down-select to proceed to the next stage of formulation. The investigations are selected to proceed from one phase to the next through execution of contract options, based on successful technical, cost, and schedule performance in the previous phases.

NASA has selected Lockheed Martin and GSFC/ARC for development of IRIS.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Space Science Support Office	06/2009	Reviewed and evaluated SMEX Announcements of Opportunity proposals for selection. Written evaluations were provided and the IRIS mission was selected for development as the next SMEX mission.	03/2011
Performance	SRB	02/2009	Overall assessment of life cycle cost, schedule and deliverables of the Explorer Program. Review board concluded that these programs have met their success criteria and should continue in accordance with their existing plans.	02/2013

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program
Project In Development:	Interface Region Imaging Spectrograph (IRIS)

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	15.8	41.1	-	37.5	11.2	6.8	1.1	0.0

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Project Purpose

Understanding the interface between the photosphere and corona remains a fundamental challenge in solar and heliospheric science. The IRIS mission will use a solar telescope and spectrograph to explore the solar chromospheres. Recent discoveries have shown the chromosphere is significantly more dynamic and structured than previously thought. The IRIS mission opens a window of discovery into this crucial region by tracing the flow of energy and plasma through the chromosphere and transition region into the corona by using spectrometry and imaging. IRIS will revolutionize understanding of energy transport into the corona and solar wind and provide an archetype for all stellar atmospheres. The unique instrument capabilities, coupled with state of the art 3-dimensional modeling, will fill a large gap in knowledge of this dynamic region of the solar atmosphere. The mission will greatly extend the scientific output of existing heliophysics spacecraft that follow the effects of energy release processes from the Sun to Earth.

Project Parameters

IRIS is a 3-axis stabilized, sun-pointed mission that studies the chromospheres in the Far Ultraviolet (FUV) and Near Ultraviolet (NUV) with 0.33 arcsecond spatial resolution, 0.4 km/s velocity resolution and a field of view of 171 arcsec. This two-year mission fills a critical observational data gap by providing simultaneous, co-spatial and comprehensive coverage from photosphere (~4,500 K) up to corona (<= 10 MK). IRIS consists of a 20cm aperture telescope assembly that feeds an imaging spectrograph and a separate imaging camera system with wavelengths in the FUV and NUV. A spacecraft bus based upon heritage designs supports the science mission and provides pointing, power, and data communications for the mission. The launch vehicle is an Orbital Sciences Corporation Pegasus XL with launch operations out of Vandenberg Air Force Base in California.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program
Project In Development:	Interface Region Imaging Spectrograph (IRIS)

Project Commitments

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Ground Systems	Lockheed Martin Space Systems Company	Receive science data and telemetry from spacecraft, command spacecraft, distribute science data to investigator teams	N/A	NEW
Spacecraft	Lockheed Martin Space Systems Company	Transport instruments to science destination, operate instruments	N/A	NEW
Instruments	Lockheed Martin Space Systems Company	Perform in situ measurements and remote observations of the Sun	N/A	NEW
Launch vehicle (Pegasus XL)	Orbital Science Corporation	Deliver the spacecraft to operational orbit	N/A	NEW

Schedule Commitments

The IRIS held a confirmation review in June 2010 and launch is planned for June 2013.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Formulation			
System Readiness Review	01/2010	N/A	01/2010
Preliminary Design Review	04/2010	N/A	04/2010
Confirmation Review	06/2010	N/A	06/2010
Critical Design Review	02/2011	N/A	02/2011
Pre-Environmental Review	10/2011	N/A	10/2011
Pre-Ship Review	07/2012	N/A	07/2012
Launch Readiness Date	06/2013	N/A	06/2013

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program
Project In Development:	Interface Region Imaging Spectrograph (IRIS)

Project Management

Lockheed Martin Space Systems is leading the formulation and implementation of the project. GSFC is responsible for oversight and science management including data analysis during operations.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Instrument	GSFC	GSFC, ARC	None.
Launch Vehicle	GSFC	KSC	None.
Spacecraft	GSFC	GSFC, ARC	None.
Mission Operations	GSFC	GSFC, ARC	None.

Acquisition Strategy

IRIS, awarded in June 2009, is a PI-led project that was competitively selected under the SMEX program. The contractor's final proposal for Phases C-E was negotiated in December 2010.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program
Project In Development:	Interface Region Imaging Spectrograph (IRIS)

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	SRB	01/2010	System Readiness Review	N/A
All	SRB	05/2010	Preliminary Design Review - received authority to enter Phase C	N/A
All	SRB	07/2010	Confirmation Review - IRIS design was deemed sufficiently mature to proceed into development.	N/A
All	SRB	12/2010	Critical Design Review - successful	N/A
All	SRB	N/A	System Integration Review (SIR) - KDP D	12/2011
All	SRB	N/A	Operations Readiness Review (ORR)	09/2012
All	SRB	N/A	Flight Readiness Review (FRR) - KDP E	11/2012
All	SRB	N/A	Launch Readiness Review (LRR)	11/2012
All	SRB	N/A	Post Launch Assessment Review (PLAR)	TBD
All	SRB	TBD	Decommissioning Review (DR) - KDP F	TBD

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Single String Spacecraft	The IRIS spacecraft uses a single string design. If there is an in flight failure, then there is no ability to switch over to a total redundant component.	Single string risks are mitigated by use of proven designs, high reliability parts, additional testing of critical systems, and testing of development models as early as possible, consistent with the cost and schedule constraints of the project.
Communications System	The communication subsystem vendor has not previously flown the proposed transmitter transponder units. If the vendor experiences problems during development of these units, then the IRIS schedule will be impacted.	Additional program manager oversight of the vendor and local quality assurance representative assigned to monitor. Engineering units are being used as a pathfinder for manufacturing and test and will be available for early testing.